



MODIS Leaf Area Index (LAI) and Fraction of Vegetation Absorbed Photosynthetically Active Radiation Products (FPAR) Products – An Update

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1. C6 Science Test Results (Credit: Drs. Sarkar and Devadiga)
2. Scientific Activities
3. Community Support
4. Concluding Remarks



1. C6 Science Test Results

- Used [L2G-lite surface reflectance at 500m resolution](#) as (MOD09GA) input in place of reflectance at 1km resolution (MODAGAGG).
- An intermediate daily surface reflectance product (MOD15IP) at 500m resolution is created from MOD09GA before being used by the LAI/FPAR PGE.
- Uses the [new multi-year land cover product at 500m resolution](#) in place of the 1km resolution land cover product used in the C5 operational processing. The new land cover product is expected to be more accurate.
- Uses the [C5 science algorithm and LUT](#).



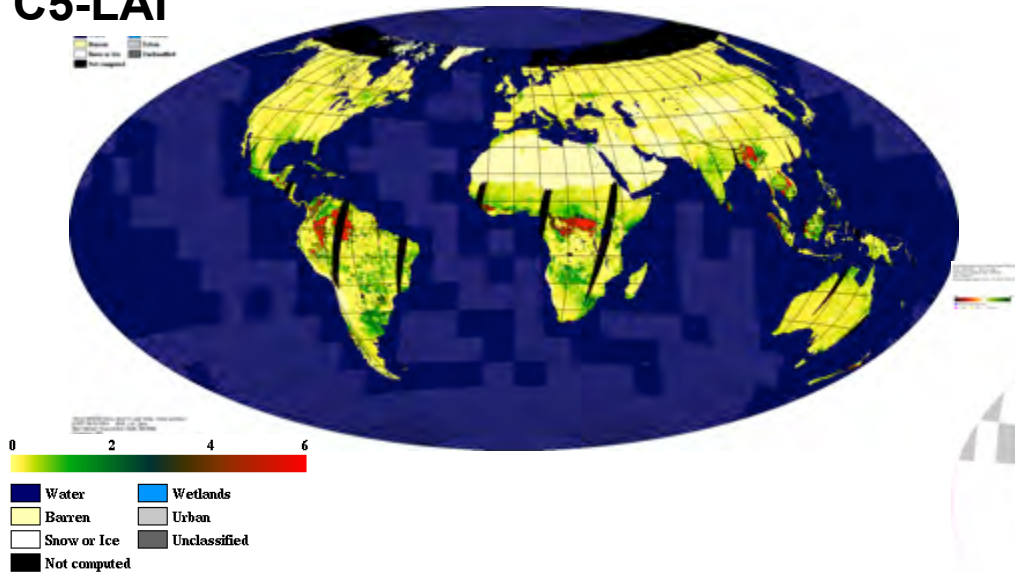
1. C6 Science Test Results

- Test Data period
 - Processed two 16-day periods starting with data day 2003-001 and 2003-193
 - Processed Terra and Aqua
- Baseline data (AS 825)
 - Input is C5 MODAGAGG and Land Cover from C5 processing (Land Cover 3)
 - Ran C5 operational version of PGE33/34/94
- Test data (AS 827)
 - Input is C5 L2G-lite MOD09GA and Land Cover Type 1
 - Ran C6 version of PGE33/34/94



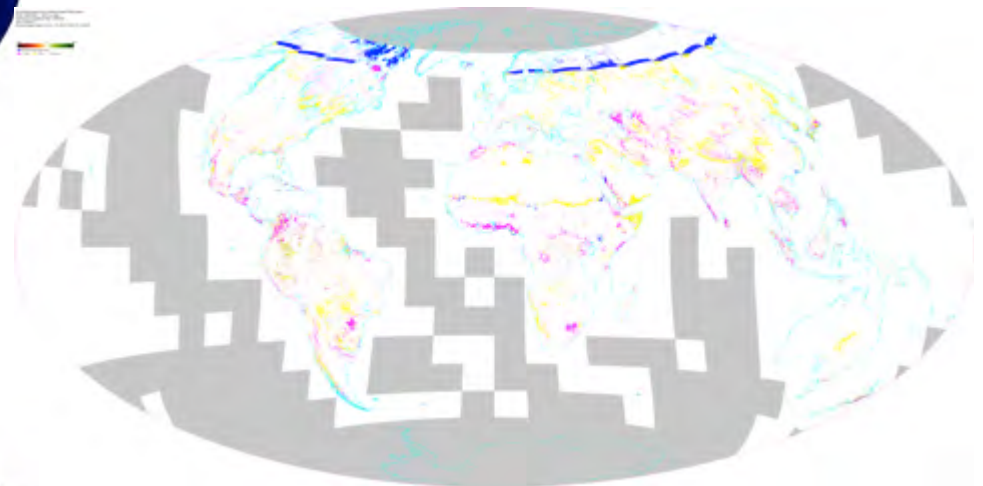
1. C6 Science Test Results

C5-LAI

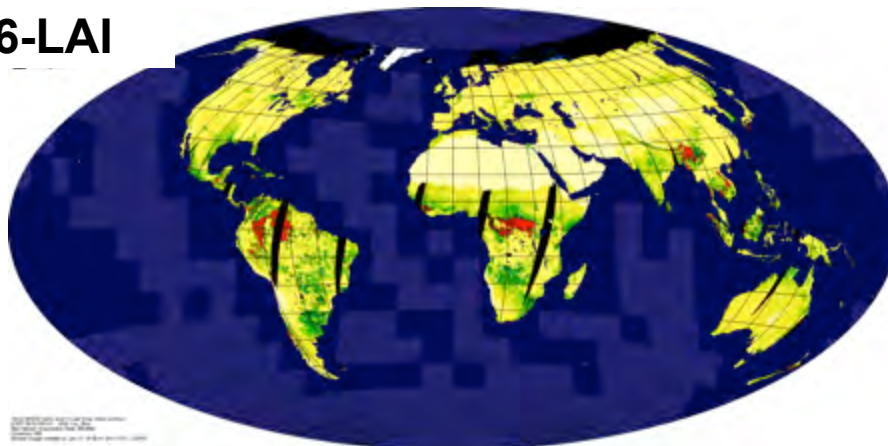


Year 2013 Day 002

Relative Diff.
 $((C6-C5)/C5)*100$



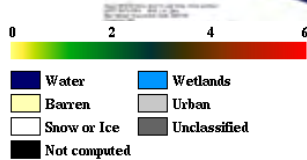
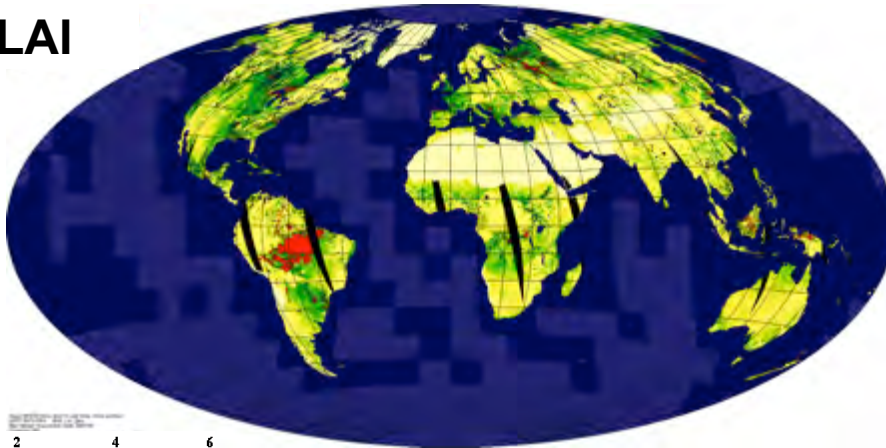
C6-LAI





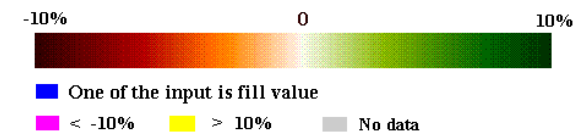
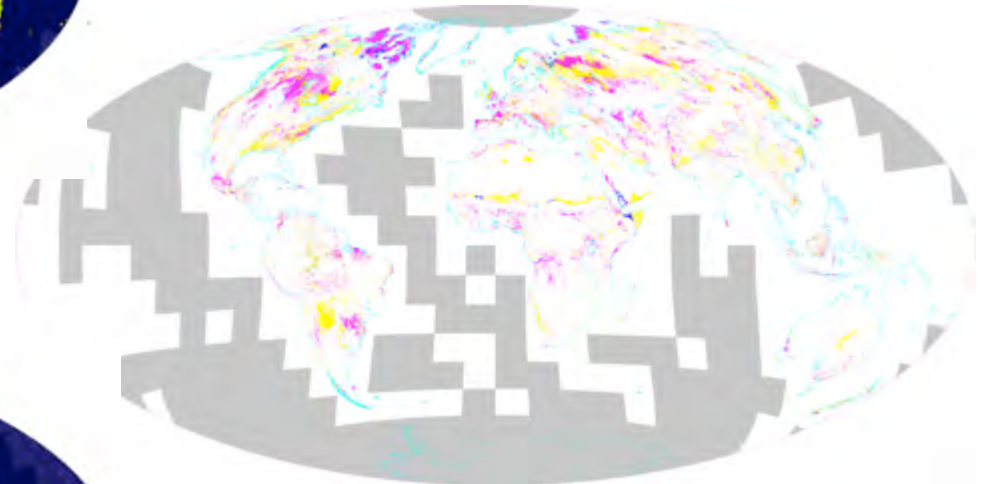
1. C6 Science Test Results

C5-LAI

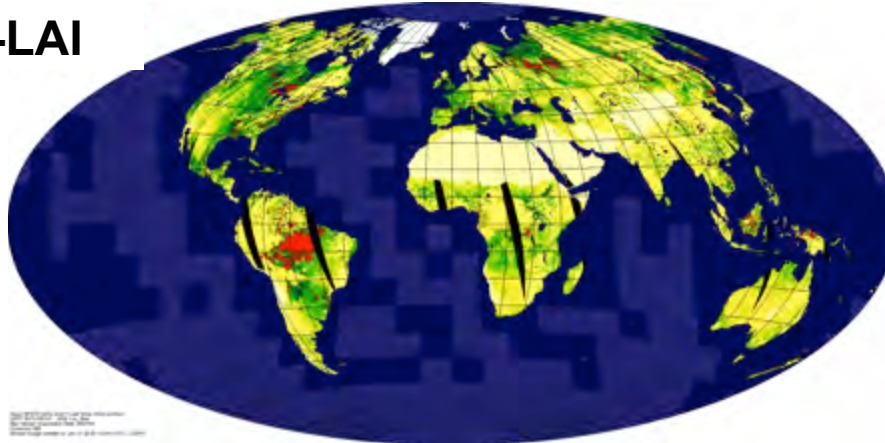


Year 2013 Day 193

Relative Diff.
 $((C6-C5)/C5)*100$



C6-LAI





1. C6 Science Test Results

Globally the C6 500M inputs seem to produce outputs comparable with C5 1KM version.

- The relative differences are mostly biased towards negative suggesting that the new C6 products are underestimating the LAI/FPAR values compared to C5.
- Over the entire global the absolute difference in FPAR is generally within $C5 \pm 0.04$ and that for LAI is $C5 \pm 0.4$

Noticed a few other issues:

- Extra coverage of $\sim 5^\circ$ in the north which is resulting from difference in threshold for solar zenith while using MODAGAGG or L2G-lite as input
- Large scale difference over areas near the Arctic circle, like Greenland mainly due to differences in the underlying land cover types used in C5 and C6.



1. C6 Science Test Results

Tile-based Analysis

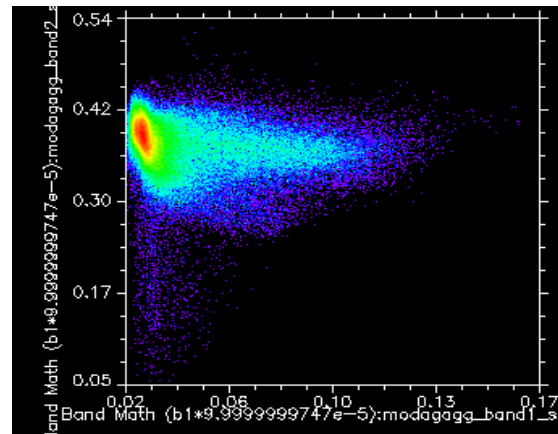
- Significant difference in both LAI and FPAR seen during summer in test tiles from central and mid-west region of US, Amazon and African Savannah.
- In general C5 output shows higher values than C6
- The bands (channel 1 and 2) for the two input data sets MODAGAGG (C5) and MOD15IP (C6) seem to be quite comparable.
- The Red bands from the two datasets are more closely related than the NIR band.
- The significant differences seen in LAI and FPAR values seems to come from the difference in Land Cover used in the baseline C5 and the new test C6.
- The Project can do limited science testing and provide diagnostics, but only the science team member can perform comprehensive analysis and develop any needed algorithm refinements to maintain the integrity of the products.



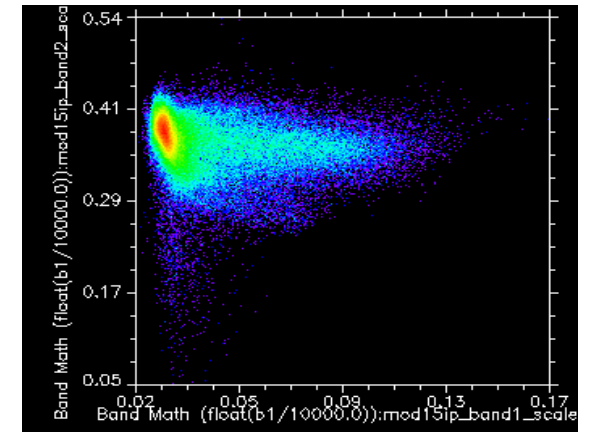
1. C6 Science Test Results

Scatter plot of Red vs NIR
H12v03 – Mid-West USA

MODAGAGG – C5

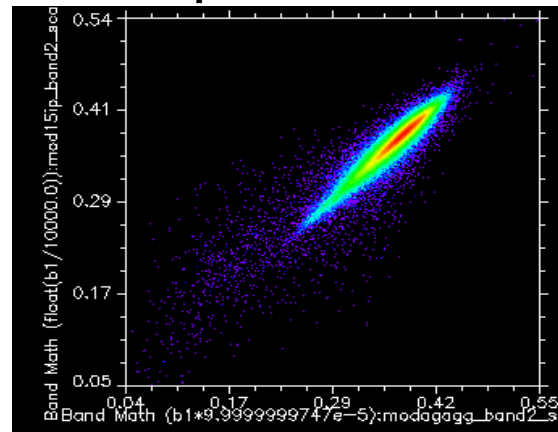


MOD15IP – C6



Scatter plot of NIR

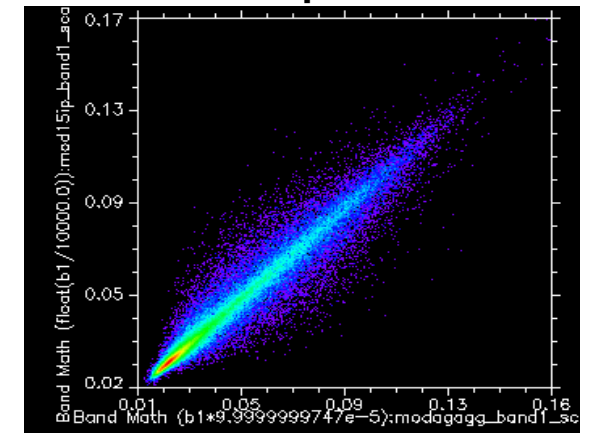
MOD15IP – C6



MODAGAGG – C5

Scatter plot of Red

MOD15IP – C6



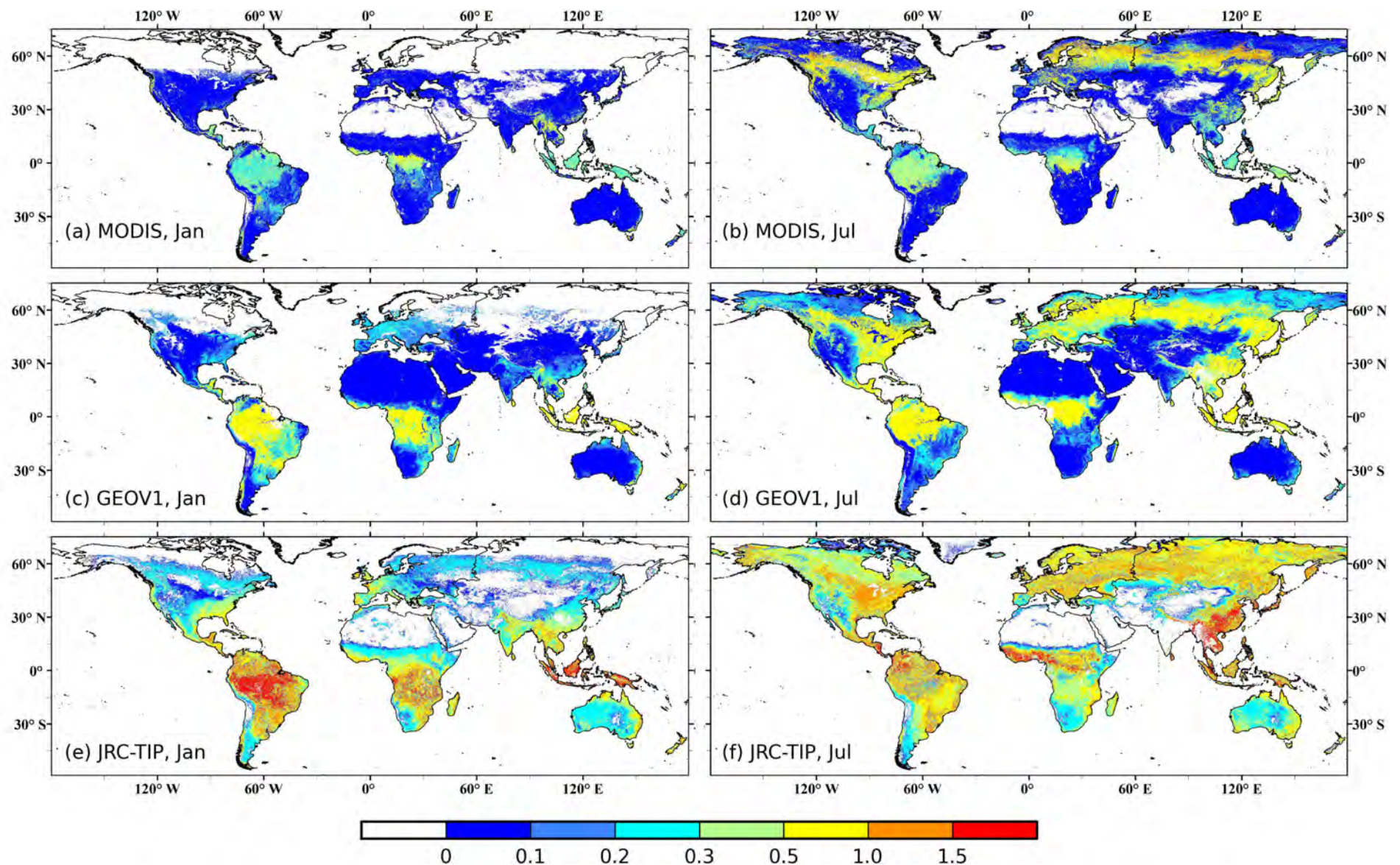
MODAGAGG – C5



2. Scientific Activities

Published Articles

- (1) Fang et al., 2013. Characterization and Intercomparison of Global Moderate Resolution Leaf Area Index (LAI) Products: Analysis of Climatologies and Theoretical Uncertainties, J. Geophys. Res. (Biogeosciences), doi: 10.1002/jgrg.20051
- (2) Mao et al., 2013. Global Latitudinal-Asymmetric Vegetation Growth Trends and Their Driving Mechanisms 1982-2009, Remote Sens. 2013, 5, 1484-1497; doi:10.3390/rs5031484
- (3) Zhu et al., 2013. Global Data Sets of Vegetation Leaf Area Index (LAI)3g and Fraction of Photosynthetically Active Radiation (FPAR)3g Derived from Global Inventory Modeling and Mapping Studies (GIMMS) Normalized Difference Vegetation Index (NDVI3g) for the Period 1981 to 2011, Remote Sens. 2013, 5, 927-948; doi:10.3390/rs5020927
- (4) Fang et al., 2013. The Impact of Potential Land Cover Misclassification on MODIS Leaf Area Index (LAI) Estimation: A Statistical Perspective, Remote Sens. 2013, 5, 830-844; doi:10.3390/rs5020830
- (5) Samanta et al. 2012. Seasonal changes in leaf area of Amazon forests from leaf flushing and abscission, J. Geophys. Res. VOL. 117, G01015, doi:10.1029/2011JG001818
- (6) Samanta et al., 2011. Comment on "Drought-Induced Reduction in Global Terrestrial Net Primary Production from 2000 Through 2009", Science, Vol. 333, p. 1093, DOI: 10.1126/science.1199048, 2011.



The average uncertainties and relative uncertainties are in the order: MODIS (0.17, 11.5%) < GEOV1 (0.24, 26.6%) < Land-SAF (0.36, 37.8%) < JRC-TIP (0.43, 114.3%) - (Fang et al., 2013).



2. Scientific Activities

Accepted/Submitted Articles

- (1) Sitch et al., 2013. Trends and Drivers of Regional Sources and Sinks of Carbon Dioxide over the Past Two Decades, *Global Change Biology* (accepted).
- (2) Poulter et al., 2013. Recent Trends in Inner Asian Forest Dynamics to Temperature and Precipitation Indicate High Sensitivity to Climate Change, *Agric. Forest. Meteorol.* (accepted).
- (3) Wang et al. 2013. Evaluation of CLM4 Solar Radiation Partitioning Scheme Using Remote Sensing and Site-level FPAR Data Sets, *Remote Sensing* (submitted).
- (4) Anav et al., 2013. Evaluation of the Carbon Cycle Components of CMIP5 Earth System Models, *Remote Sensing*, (submitted).



3. Community Support

- (1) Generating higher quality, but downscaled, MODIS LAI and FPAR products from standard MODIS products and distribution via the PI web site.
- (2) Producing “custom” products for certain class of users (CMIP5, Carbon/Ag/Hydrology/Atmospheric Chemistry/etc. modelers).
- (3) Research on developing a LAI/FPAR CDR (AVHRR-MODIS fused product time series) and distribution to the community – currently distributing a 30 year LAI/FPAR data set.
- (4) The long-term data sets seem to be in much demand by the vast majority of users where the focus is on climate change science needs.



4. Concluding Remarks

- The Project can do limited science testing and provide diagnostics, but the science team member can perform comprehensive analysis and develop needed algorithm refinements to maintain the integrity of the products. This is clearly the case with C6 MODIS LAI/FPAR
- MODIS LAI/FPAR products are the “best” of the current crop of LAI/FPAR products.
- Product “quality” cannot be assured without the PI as the “gate keeper”
- As the length of the time series is increasing, the scientific community is increasingly reaping the rewards from MODIS.
- We need to continue the “tried and tested” model of a science team behind a live MODIS mission.